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Air sparging is the process of injecting clean air directly into an aquifer for remediation of contaminated groundwater. For removing contaminants, air sparging relies on two basic mechanisms working either alone or in tandem: biodgradation and volatilization. The objective of air sparging is to force air through contaminated aquifer materials to provide oxygen for bioremediation and/or to strip contaminants out of the aquifer.

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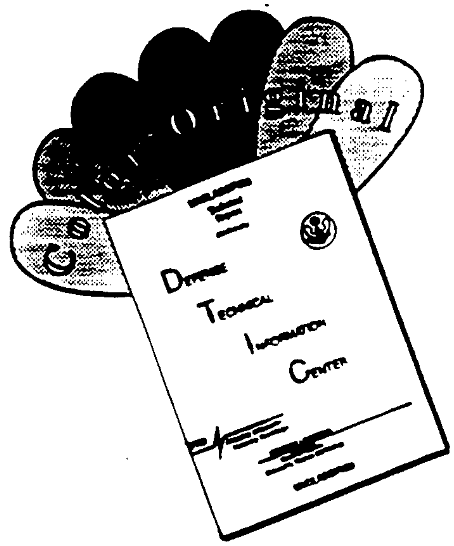

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TechData Sheet
Naval Facilities Engineering Service Center
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SERDP Strategic Environmental Research and Development Program
Improving Mission Readiness Through Environmental Research

TDS-2029-ENV (Revised) March 1997

Advanced Fuel Hydrocarbon Remediation National Test Location

In Situ Air Sparging System

Conducted by:

Armstrong Laboratory Environics Directorate, Tyndall Air Force Base, FL;
Battelle Columbus Division, Columbus, OH;
Mission Research Corporation, Albuquerque, NM;
Oregon Graduate Institute, Beaverton, OR;
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Air sparging is the process of injecting clean air directly into an aquifer for remediation of contaminated groundwater (Figure 1). For removing contaminants, air sparging relies on two basic mechanisms working either alone or in tandem: ***biodegradation*** and ***volatilization***. The objective of air sparging is to force air through contaminated aquifer materials to provide oxygen for bioremediation and/or to strip contaminants out of the aquifer.

Bioremediation refers to enhancing the growth of naturally occurring microorganisms that use contaminants such as petroleum products as a food source. In so doing, contaminated areas can be remediated naturally, with contaminants detoxified.

Potentially, air sparging is applicable to sites contaminated with petroleum hydrocarbons such as jet fuels, diesel fuel, and gasoline, as well as volatile compounds (such as chlorinated solvents).

Several new monitoring methods (Figure 2) are being developed and tested in conjunction with the investigation of this remediation technology.

Monitoring Techniques

Air sparging monitoring techniques under investigation include: high-impulse borehole radar imaging, electrical resistance measuring and in-situ pressure, and flow sensor technologies. Also included are soil vapor extraction testing, groundwater analysis, and fuel hydrocarbon vapor off-gassing-from-soil testing, each of which may use sulfurhexaflouride (SF_6), and helium, as tracer gasses.

High-impulse borehole radar (see Figure 3) imaging is used in the process as a means to image airflow characteristics in the subsurface -- such as radius of influence, air channeling, and trapped air distribution. A signal, or transient pulse, is radiated into the ground, while the soil acts as a lowpass filter. Frequency characteristics are controlled by the soil's physical properties: water content, air distribution, and dissolved solid concentration. Transmitting and receiving antennas are lowered separately into nearby boreholes while measurements are taken at various depths. The antennas obtain electromagnetic data used to create images reflecting where objects, structures, and formations are located underground.

Measuring aquifer electrical resistance is done by using a three-dimensional array of electrodes placed in the ground near the sparge area. Background resistance measurements are taken prior to sparging startup and then again 1 or 2 days later. A detailed picture of air distribution patterns created by the sparging process is developed from the data.

Miniaturized in-situ pressure sensors are deployed in the subsurface to determine pressure differentiation within the sparge area and to define horizontal and vertical water and air transport from the sparge region. At various depths inside PVC pipes (see Figure 4), these sensors are mounted and are exposed to soil, water, and air pressure via small ports. They

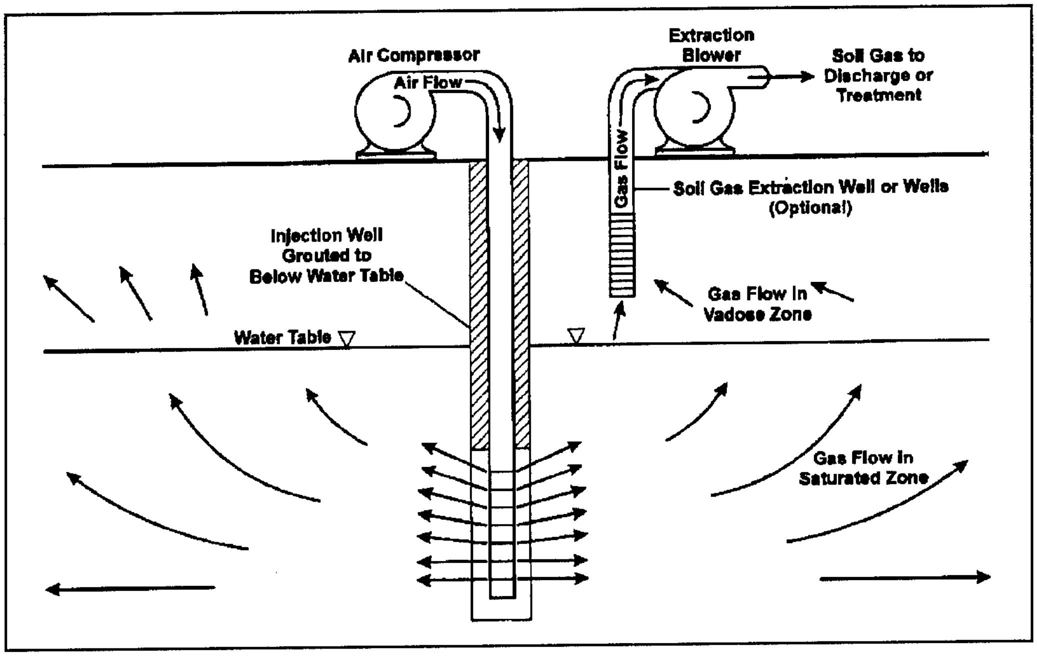

Figure 1. In-situ air sparging system.

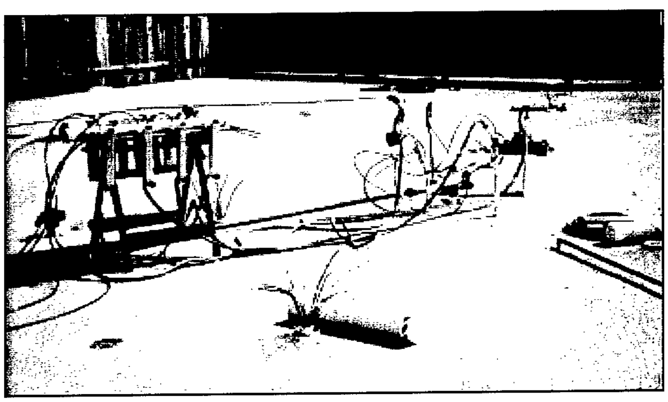

Figure 2. New equipment used to monitor air sparging.

Figure 3. High-impulse borehole radar.

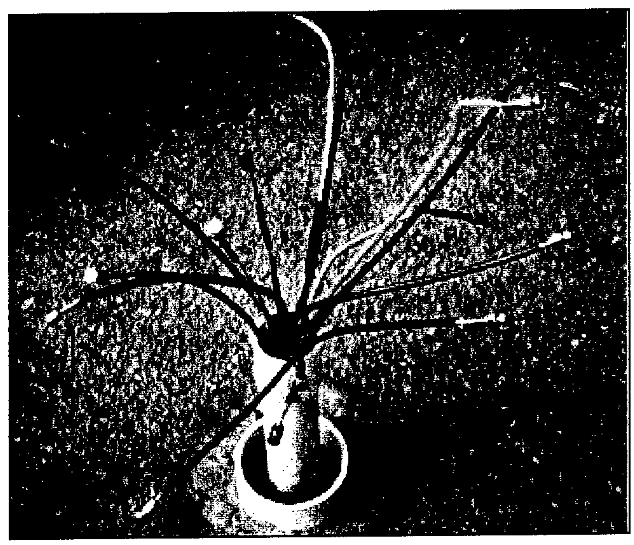

Figure 4. Miniaturized in-situ pressure sensors.

are connected to a data acquisition computer system that supplies real-time data transfer.

In-situ groundwater flow sensors are deployed in the subsurface and are capable of detecting very slow (as low as a few meters per year) flow velocities. The technology uses a thin cylindrical heater and thermistor system buried vertically in the water-saturated zone. Groundwater flow past the heater changes the probe surface temperature, developing variations that reflect the direction and magnitude of the flow. The flow sensors are connected to the same data acquisition system as the pressure sensors. Both systems continuously collect data that can be transferred, by modem, to an off-site computer for analysis, thus eliminating the need to visit the site. A

three-dimensional groundwater flow pattern can be recorded with a single sensor for a given area.

An ***SF_6* injection study**, or ***tracer test***, is a process by which a small quantity of SF_6 (a non-toxic gas) is combined with the air stream during the air sparging injection process and forced into the aquifer. Its appearance in soil off-gas and groundwater samples is then monitored over time. The SF_6 gas is chosen for this type of procedure because its chemical properties are similar to those of oxygen and it is easy to detect in vapor and groundwater samples at very low concentrations. Data from these tracer tests are used to identify air flow distribution patterns in the aquifer.

Helium tracer tests are conducted in a manner similar to the SF_6 tracer tests. Helium is forced into the subsurface, then vapor and groundwater samples are collected over time. Data generated helps identify possible problems with contamination migration and determine the effectiveness of the air sparging system.

Fuel hydrocarbon vapor off-gassing-from-soil testing involves enclosing an area of surface soil in the air sparge system under an inert box. This box is designed to allow its own purging with high-purity air via inlet and outlet ports. Once ambient air is removed from the box, an equilibrium is established between the hydrocarbons emitted from the soil and organic-free air. An air sample is then taken from the box and hydrocarbon emission rates are calculated. A tracer gas, such as SF_6 or helium, can be used to verify results.

Air Sparging Monitoring at Port Hueneme

Monitoring air sparging operations will provide information to assess contaminant removal rates given different and changing environmental parameters. Information obtained from these operations will help evaluate the overall effectiveness of, and provide system design data for, air sparging as a remediation technology. Data generated from separate innovative monitoring techniques will be compared to one another to determine which methods provide a more accurate representation of changing site conditions and remediation progress.

Advantages

- It may clean a petroleum-contaminated aquifer easily.
- By promoting biodegradation, it has the potential to completely destroy contaminants, instead of transferring them to another media.
- It leaves the site intact, yet removes the contaminant.
- It costs less and is more effective than an on-site pump and treatment system.

For more information on the ***in situ air sparging system***, contact:

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